Development of Cotton and Associated Beneficial and Pest Insect Populations in a Ratoon Field at Phoenix, Ariz.

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ABSTRACT

A 14-ha ratoon cottonfield near Phoenix, Ariz., was studied during the 1978 cotton growing season. Observations were made on the development of beneficial and pest insects as well as development of the cotton plants.

The first blooms, observed on April 27, were from buds produced the previous season. New growth produced flowers by mid-May, and peak flowering occurred during the first week in June. Bolls were available in the field by early June and were at peak numbers by the end of June. Open bolls appeared in early July and defoliant was applied August 25. Cotton yield exceeded the 1977 yield by about 10 percent. Fifteen applications of insecticide, 16 irrigations (1.78 m of water), and 1 application of a nitrogen fertilizer were made on the field during the season.

Approximately 13,000 pink bollworm males were trapped in the field during April, but the pink bollworm did not become an economic pest until mid-June (18 percent boll infestation). The pink bollworm was controlled by the insecticide program during the rest of the season. *Heliothis* eggs and damaged terminals were present throughout the season, but the damage did not become economically important until August when applications of insecticides specifically designed to control *Heliothis* were required. Termination of the crop in late August ended the insect problems.

The grower achieved economical production of cotton in this field because the advantages of early cotton production were not offset by the insecticide costs associated with protection of late-season cotton.

KEYWORDS: *Heliothis*, *Pectinophora gossypiella*, ratoon cotton, stub cotton, cotton plant development, predators of insect pests of cotton.

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DEVELOPMENT OF COTTON AND ASSOCIATED BENEFICIAL AND PEST INSECT POPULATIONS IN A RATOON FIELD AT PHOENIX, ARIZ.

By H. M. Flint, S. S. Salter, and S. Walters[1]

INTRODUCTION

Cotton production in Arizona in 1978 included about 18,000 ha of stub cotton. This was made possible by an exceptionally mild winter that left viable rootstocks, even in unprepared beds, and the decision of the Arizona Commission of Agriculture and Horticulture (ACAH) to approve experimental fields of stub cotton. Production of stub cotton is not new in Arizona. It was produced irregularly until 1966 when the option of stubbing was removed by ACAH regulation. Prior to 1966, the populations of the pink bollworm, *Pectinophora gossypiella* (Saunders), were increasing in spite of efforts to control the pest. Arizona has experienced outbreaks of the pink bollworm during 1929-34, 1938-46, and from 1958 to the present (Noble, *1969*).[2] The early infestations appeared to be controlled by cultural and quarantine practices.

Stub cotton production is generally considered to be inconsistent with good cultural control practices for the pink bollworm. This pest overwinters (diapauses) in the larval stage, and the diapausing larvae are produced in cotton bolls grown in late in the season (as occurs in late-season or stub cotton production). The normal practices of shredding and plowing-under infested plants early in the fall is not practiced in stub cotton production. Thus, diapausing pink bollworms are likely to overwinter in greater numbers. Furthermore, early growth of stub cotton in the spring provides food for the emerging moths. Noble (*1969*) indicated that stub cotton production should be avoided in areas where pink bollworm is an economic pest.

We conducted an intensive survey program on a single field of ratoon cotton during the 1978 season. The field selected was unique because the cotton received no cultural treatments between picking and cultivation early in the spring. This ratoon field provided optimal conditions for early season study of the development of both pest and beneficial insects.

The terms "stub," "perennial," and "ratoon" are often used interchangeably to describe cotton produced on rootstalks from the previous season. We choose

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[2] The year in italic, when it follows the author's name, refers to Literature Cited, p. 12.

to call our experimental field a ratoon field since the stalks were not cut and shredded as is the usual procedure in stubbing. This terminology distinguishes our primary experimental field from other fields discussed in this work.

MATERIALS AND METHODS

The test field consisted of 14 ha of Deltapine cotton (D & PL 61) planted in March 1977. The field, located in southeastern Phoenix, was an antho sandy loam soil type with a 1- to 3-percent slope (Robert Reginato, USDA soil scientist, unpublished communication), which required more frequent irrigation than heavier soil types with less runoff. The cotton was planted on 0.9-m rows and had approximately 3.5 plants/m during the 1978 season. The yield was about 4.4 bales/ha in 1977. Irrigation of the field was initiated April 29 and continued on about a 1-week schedule until termination of irrigation on August 20 (16 applications, 1.78 m total water). One application of a nitrogen fertilizer at 336 kg/ha was made in the irrigation water on May 21. Weed control during the 1978 season was by field labor, once in April and again in late May.

Insecticide treatments were initiated on June 7 with ground application of 0.84 kg of parathion/ha. The treatment was repeated on the 22d. On June 27, July 2, 6, 10, 13, and 19, ground applications of 1.1 kg of parathion and 2.2 kg of toxaphene/ha were made (the July 2 treatment was 0.9 kg of monocrotophos). On July 26, 1.7 kg parathion and 1.1 kg of toxaphene were applied. On July 30, August 5, 9, and 15 various combinations of resmethrin and parathion were applied. On August 25, 1.7 kg of parathion, containing the defoliant DEF©, was applied. These 14 applications, all by ground equipment, were made primarily for the pink bollworm early in the season and for *Heliothis* late in the season.

We began our study by placing 12 Delta traps containing 1 mg of gossyplure in the field on March 27. These traps were arranged in four rows of three traps each and effectively covered the interior field (traps were not placed at the edges of the field). The number of traps was reduced to nine late in the season to facilitate servicing. Catches were recorded and traps were replaced daily during the week.

De Vac samples[3] were collected weekly from April 11 to June 30. The field was divided into three equal sections, and a sample from 15 m of row was collected from the center of each section. (The three samples were averaged to provide the data for the sample date.) Samples were returned to the laboratory, killed with ethyl acetate, and examined microscopically. The total numbers of green lacewings, *Chrysopa carnea* (Say), assassin bugs, *Sinea* spp., damsel bugs, *Nabis* spp., big eyed bugs, *Geocoris* spp., minute pirate bugs, *Orius* spp., convergent lady beetles, *Hippodamia convergens* (Guer.), and striped collops, *Collops vittatus* (Say) were recorded. We also noted other insects such as cotton aphids, *Aphis gossypii* (Glover), cotton leafperforators, *Bucculatrix thurberiella* (Busck), and *Lygus* bugs, *Lygus hesperous* (Knight).

We estimated the numbers of flowers, firm green bolls, and open bolls week-

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[3]Mechanically aspirated collections of insects.

ly from May 24 to August 25. The field was divided into four equal sections. Two samples of 8 m of row were taken at opposite ends of each section. From these counts, we obtained an estimate of the number of fruit forms per hectare.

Samples of 200 firm green bolls (14 to 21 days old) were collected each week from June 7 to August 16. Each sample was composed of 50 bolls taken at random from each quadrant of the field. These samples were held over paper towels in ventilated plastic boxes (Fye, *1976*) for 2 weeks at 27°C before larvae, pupae, and adults were counted.

Sweep-net samples were taken weekly from April 27 to July 6. Three samples of 100 sweeps each were taken from the field on each sample date (one from each one-third of the field). The samples were examined in the laboratory for nymphs and adults of the *Lygus* bug, and the numbers were averaged for the three samples. We also noted the captures of green lacewings.

On July 14, the plant development in the test field was compared with plant development in three other stub fields and three planted fields. The stub and planted fields were all within a 10-km radius of the test field and were under the management of different growers. Observations on flowers, bolls, and open bolls were made in all seven fields by counting three samples of 30.5 m each per field (each field was divided into three sections). The three samples were averaged for each field and then compared using a computer programmed to perform analysis of variance on data with missing plots. A Duncan's multiple range test was then used to separate means into significant ranges (P = 0.05 percent in the analysis).

We also compared the numbers of main stalks per plant in the test field with five stub and three planted fields within a 10-km radius of the test field. These data were collected from each field by dividing the field into five sections and observing 10 plants in a row from the center of each section. An average value for the field was determined from these five samples, and the average field values were compared statistically as in the preceding test.

RESULTS AND CONCLUSIONS

Observations on the Field

The first bloom was observed on April 27, and there were numerous blooms during the following week. These flowers were about one-third normal size and were from buds formed during the preceding season. The new plant growth took the form of multiple stalks developing around the previous season's dead stalks. By mid-May, new growth was producing flowers (fig. 1). Flowering proceeded rapidly through the remainder of May with peak flowering occurring the last few days of May and the first few days of June. Thereafter, flowering declined until the latter part of June when flower production increased to a second (lower) peak in mid-July. Flowering declined slowly until the middle of August and precipitously during the last 2 weeks of August.

Firm green bolls (14 to 21 days old) were available in late May and increased in number steadily until the end of June (fig. 1). The numbers of green

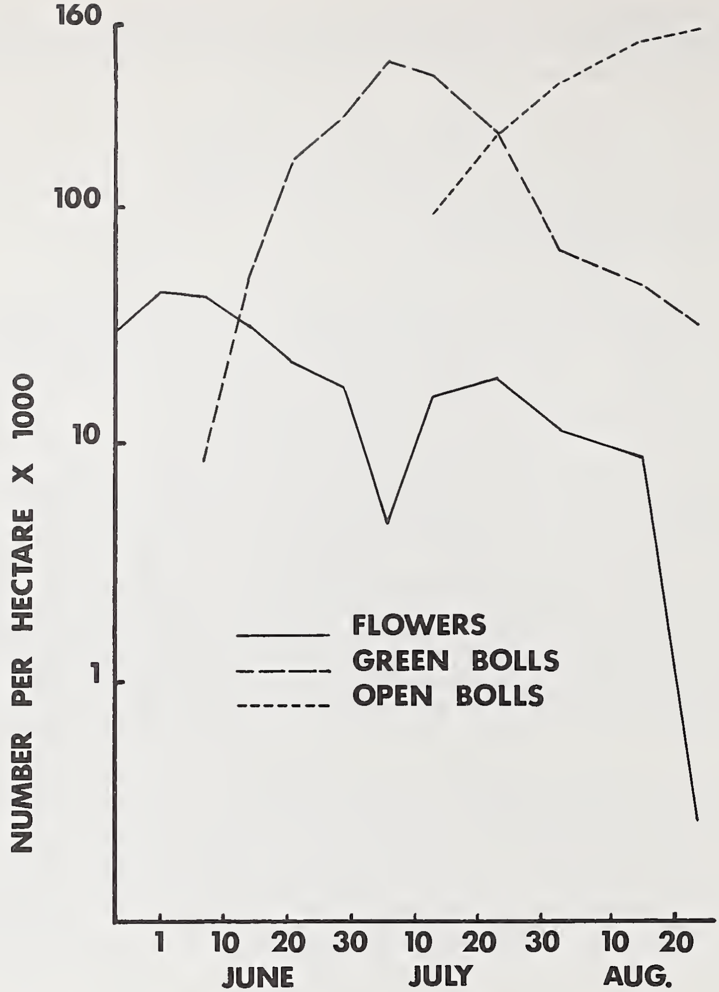

Figure 1.--Production of flowers, green bolls, and open bolls in the ratoon field at Phoenix during the 1978 season.

bolls declined throughout the remainder of the study (end of August). Open bolls were abundant by early July and increased steadily thereafter. Picking was conducted October 8 with a yield of 1100 kg of lint/ha (about 10 percent greater yield than in 1977). The grower experienced some difficulties in picking due to the dead stalks remaining in the cotton from the 1977 season.

Observations of Minor Pests

Larvae of the cotton leafperforator were found on new growth leaves in late April; however, populations failed to develop, and adults and leaf damage were not noted until early August. This pest was apparently held in check by its parasites or predators from April to mid-June.

Infestations by the cotton aphid were severe on new plant growth in early May; however, the infestations were dramatically brought under control by a Braconid wasp (*Aphidius* spp.). Our De Vac samples obtained early in May contained thousands of mummified aphids with characteristic emergence cutout holes in their abdomens. In some samples, these mummified bodies resembled coarse sand in the sample counting plates. Aphids were no longer present in the field by late May.

Populations of the cabbage looper, *Trichoplusia ni* (Hübner), were observed in the cotton during late July and were causing some defoliation by early August. This damage, however, was not considered economically important.

Observations of Major Pests

Pink Bollworm

Trap catches of the pink bollworm attained levels of 60 males/trap per night during the third week in April (fig. 2). From our data, we estimate that our 12 traps in the test field removed nearly 13,000 males (or 889 males/ha) during April.

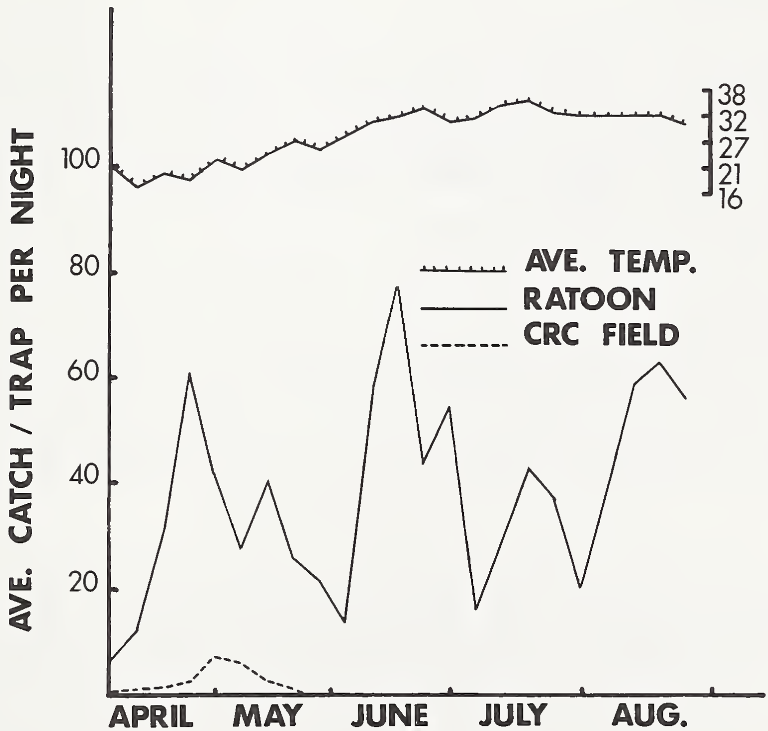

Figure 2.--Catches of the pink bollworm by Delta traps baited with gossyplure in the ratoon field and on the Cotton Research Center (CRC) farm during the 1978 season (daily mean temperature in degrees Fahrenheit is provided).

For comparison, we placed four traps in a 3.6-ha field to be planted on the Cotton Research Center (CRC) farm, 3.2 km from the test field. This field was in cotton during the 1977 season and was part of a complex of adjacent fields comprising 27 ha of cotton during the 1977 season. (With the exception of 2.7 ha in mixed plots, this complex received chemical control for pink bollworm during the 1977 season.) Except for a 0.03-ha experimental plot of stub cotton, the entire CRC farm was not planted until April 21-27. Thus, these four traps were in an area of pink bollworm emergence that did not have significant stub cotton available. In fact, the nearest cotton in April, aside from the stub plot, was our experimental field. These four traps captured about 350 moths in April (or 97 males/ha) (fig. 2). Trap density was comparable at the two locations: 5.7 traps/ha on the CRC farm, 7.2 traps/ha in the ratoon field.

Populations of pink bollworms in the ratoon field attained an average of 40 males/trap during mid-May. This peak corresponded with the onset of flowering and led us to look for larvae in blooms (rosettes). Strangely, observations of 250 or 300 flowers on May 17, 21, 24 and 31 resulted in findings of about 1 larva/100 blooms. For the numbers of moths present, this was considered a very low bloom infestation. The explanation may be the large numbers of predators in the unsprayed field at this time (predator counts are presented elsewhere). By mid- and late May, the plants had developed a canopy that provided habitat for predators as well as food and shelter for pink bollworms. We suspect that the relatively exposed position of the pink bollworm eggs and larvae provided early food for the predators.

Further peaks in trap catches occurred during the 2d and 4th weeks of June (fig. 2). The greatest catches of the observation period occurred during mid-June: 79 moths/trap per night. Susceptible cotton bolls were readily available in June; the highest boll infestation of 20 percent was recorded on June 21. The first insecticide application was made on June 17 for control of the pink bollworm. The boll infestations declined after mid-June. (They did not exceed 8 percent during July and August.)

Peaks in trap catches of pink bollworm occurred in mid-July and August. Unlike previous peaks in trap catches, the July and August peaks were discreet without associated secondary peaks. It is interesting to compare the trapping records for the ratoon field with those of the CRC farm (planted fields with no stub cotton in the area) obtained during the 1976 season (Flint et al., *1976*). The CRC data indicated the first minor peak of trap capture during mid-April with a buildup thereafter to a major peak in mid-May; however, the captures of moths on the CRC farm never exceeded two moths/trap per night during April to July, 1976 (Flint et al., *1977*), a very low population.

Our data provide for a comparison of trap catches with percent boll infestations and actual numbers of pink bollworm larvae per hectare (fig. 3). The June peak in trap catches was followed by a decline in total larvae per hectare about a week later; however, in mid-July both trap catches and total larvae reached peaks simultaneously. Thus, trap catches did not accurately estimate actual larval infestations during the critical June to July period. The percentage of boll infestation, which is normally monitored by the grower, presented an equally uninformative relationship with trap catches. The grower was probably right in spraying for pink bollworm on June 17. (He had economically significant boll infestations and very high trap captures at this time.)

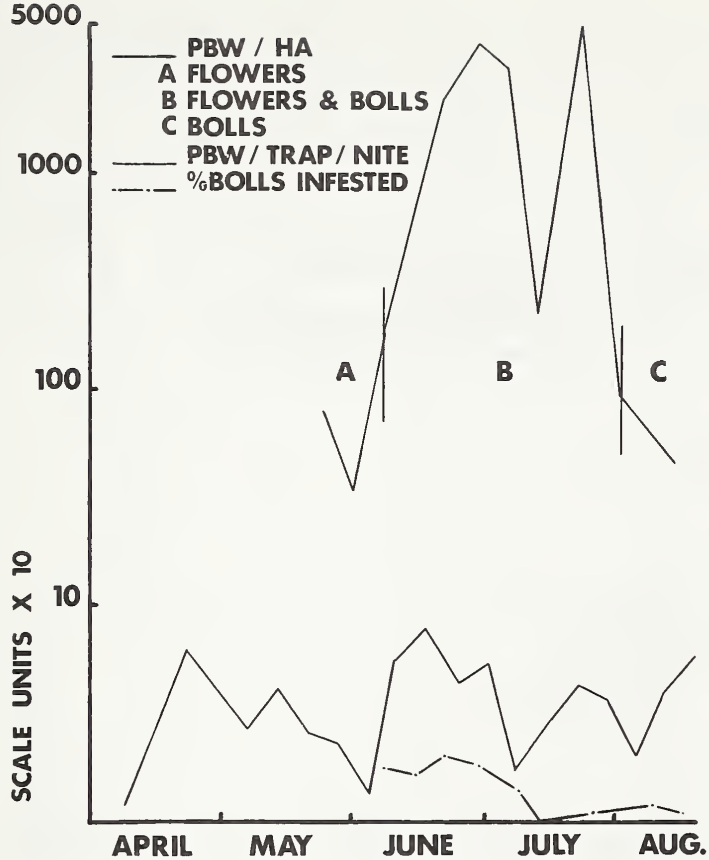

Figure 3.--Total pink bollworm per hectare compared with catches of adult moths in gossyplure baited traps and percent infested bolls in the ratoon field.

Because the grower embarked on an irregular spray schedule after this first application, it was not possible to relate trap catches to boll infestations thereafter. Boll infestations were successfully controlled by the spray schedule, whereas trap catches continued to fluctuate (although peak catches in July and August did not show the 10 to 20 times increase normally expected of uncontrolled pink bollworm populations in fruiting cotton).

We cannot predict what would have occurred had the grower made applications to control aphids or the pink bollworm in April and May. We feel, however, that the grower's restraint in the face of tremendous trap catches in May paid off in chemical savings and preservation of predator populations. We believe that high trap catches in the absence of boll infestations do not indicate the need for applications of insecticides.

Lygus Bugs

Lygus bugs per 100 sweeps ranged from 7 to 15 from April 27 to June 8 (fig. 4). The number of nymphs exceeded 22 percent of the total capture only

in the sample taken May 3 (46 percent nymphs). After June 8, the *Lygus* population rapidly declined to zero, and collections were discontinued after July 6. The population decline was well underway before spraying was initiated.

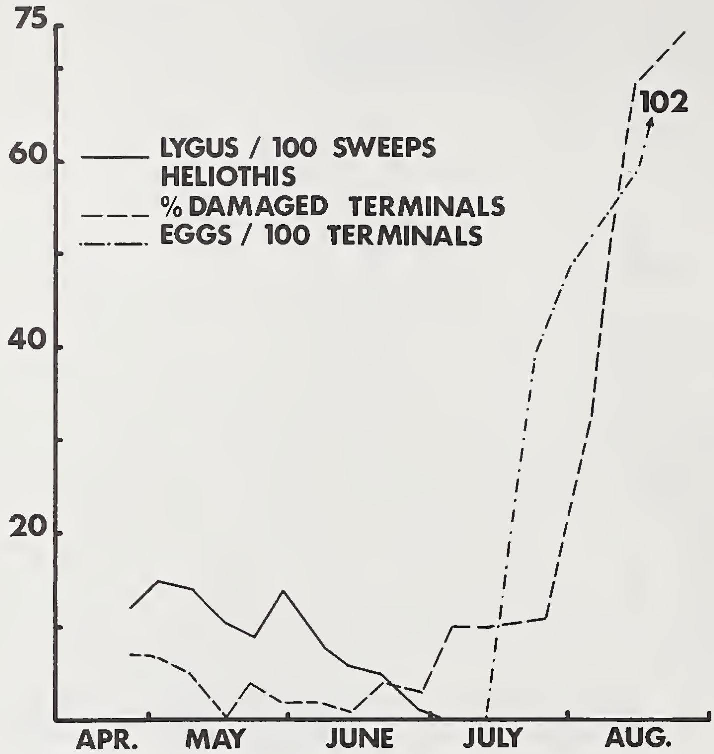

Figure 4.--Populations of *Lygus* and *Heliothis* in the ratoon field during the 1978 season.

Heliothis

We were particularly aware of the threat of *Heliothis* throughout the season. During May to July, up to 200 *Heliothis* males were captured per night in a trap baited with five virgin female moths operated in the field (Peter Lingren, personal communication). Our observations on *Heliothis* were limited to weekly observations of 100 terminals (fig. 4). These observations indicated a continuous low level of damaged terminals (usually < 10 percent); however, in late July, damaged terminals increased dramatically. This increase was presaged by an increase in the numbers of eggs found on terminals. (From April 27 to July 13, we found 0 to 4 eggs/100 terminals, with no eggs in eight samples.) By mid-August, nearly 100 percent of the terminals had eggs and/or damage, and economically significant damage to green bolls was occurring. The grower began resmethrin applications tailored for *Heliothis* on July 30. These and subsequent applications appeared to have little effect although the number of available green bolls and new plant growth was declining. Irrigation was terminated late in August and defoliant was applied on August 25, effectively ending the *Heliothis* problem.

Predators

De Vac samples initiated in early April indicated the presence of all major predators in the new plant growth (fig. 5). These populations generally increased until the first insecticide parathion application on June 17 and then dramatically collapsed. *Chrysopa* was the only species apparently declining before the first application of insecticide. Our sweep net samples averaged 17 green lacewings per 30.5 m of row from May 11 to June 8. Not shown in figure 5 were the populations of convergent lady beetles. This predator was found primarily in May, averaging about four per 15-m sample. The minute pirate bugs also appeared primarily in May (fig. 5). They were thought to be effective predators on eggs and young larvae of both *Heliothis* and the pink bollworm.

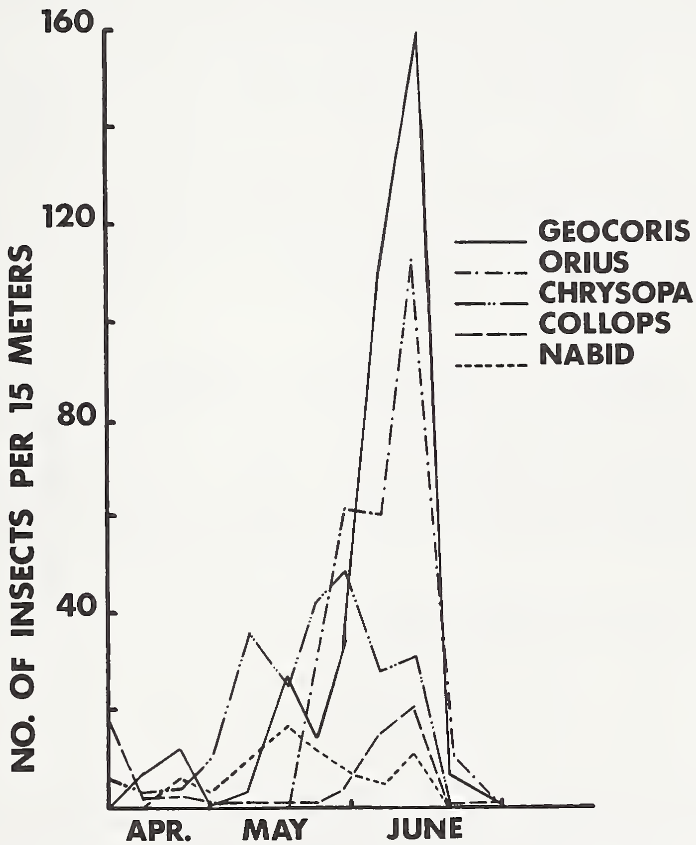

Figure 5.--Populations of predators in the ratoon field during the early part of the 1978 season.

We believe that the populations of predators were a major contributing factor in the failure of pink bollworms to successfully infest flowers in May. We have already noted that parasitic wasps effectively reduced the populations of the cotton aphid in April. Parasites and predator populations were decimated by the spray schedule maintained after June 17.

Plant Development

Comparisons of stub and planted fields with the ratoon field on July 14 indicated significantly more green bolls and open bolls in the ratoon and stub fields but fewer flowers (table 1). Our observations of the fields led us to believe that the ratoon and stub fields were about 3 to 4 weeks ahead of the planted field in crop development. Plant height was comparable in all the planted fields, but observations on October 10 indicated significantly greater numbers of main stems per plant. We found no major differences between the ratoon and stub fields.

Table 1.--*A comparison of plant development in the experimental field and planted or stub cottonfields within a 15-km radius*

Treatment	Fruiting forms per hectare on 7/14/78[1]			Plant height 7/14/78	Main stems per plant 10/12/78[2]
	Flowers	Green bolls	Open bolls		
	Number	*Number*	*Number*	*Meters*	*Number*
Planted fields	41,183 a[3]	113,781 a	0 a	0.68	2.0 a
Stub field	10,023 b	366,014 b	15,632 b	.68	4.4 b
Experimental field	16,881 b	354,704 b	91,209 b	.78	4.7 b

[1]Based on averages of 3 30-m samples in each of 3 stub and 3 planted fields.
[2]Based on averages of 5 10-m samples in each of 3 stub and 3 planted fields.
[3]Means followed by the same letter are not different based on the 0.05 levels of Duncan's multiple range test.

DISCUSSION

Ratooning or stubbing of cotton to obtain perennial plants is an idea that is periodically rediscovered. Historically, perennial cotton production was practiced because the native plants were perennials and produced better yields after the first year's growth; however, in the United States cold temperatures prevent widespread perennial cotton production. In Arizona, the temperatures usually preclude perennial cotton production except by special farming methods that protect the vulnerable root-stock. Thus, perennial cotton production has not become widespread in the United States and is not always an option in Arizona.

Worldwide, perennial cotton production has resulted in significant increases in insect pest populations in the past (Evenson, *1970*). Templeton (*1925*) and Wene (*1965*) implicated increased populations of the pink bollworm

with perennial cotton. Many major cotton-producing nations have legislated against perennial cotton at one time or another (Van Schaik et al. *1962*). Rainey and Smit (*1950*) indicated that for South Africa "There is now abundant evidence of the effects of ratooning in encouraging the major pests of cotton in the Union." This conclusion was also reached by Naude (*1965*) and Mulder (*1965*) in the Transvaal region.

More recent literature, however, indicates that changes in pest control technology may have altered the situation in some areas. Ellern (*1966*) states: "The decision whether to allow ratooning of cotton must be made for each producing area in light of local conditions." He further states" "...in no case did ratoon cotton in Israel serve as a focal point for pest out-breaks in either ratoon or neighboring planted cotton fields. It is true that the earliness of ratoon cotton necessitates earlier spraying, but the spraying program may also be ended earlier, and ratoon cotton may escape pest attacks which are frequent towards the end of the season." Arndt (*1961*) reached a similar conclusion for ratoon cotton crops in the Northwest territory of Australia: "...pests and diseases did not become serious."

The pink bollworm has been Arizona since 1926 and in the Salt River valley since 1929. Control of the pink bollworm in Arizona has always involved cultural controls although the advent of effective and readily available insecticides appeared to reduce the need for cultural controls. It was into this atmosphere that the detrimental aspects of insecticides were brought to public attention more than a decade ago.

Renewed interest in noninsecticidal control of insects ushered in many beneficial practices, including crop rotation, cultural practices to reduce overwintering of pink bollworm, and scouting of cotton to determine timing of insecticide applications. Van Schaik (*1962*), however, indicated that stub cotton production in Arizona from 1954 to 1960 lead to significant increases in leaf crumple virus, and Wene (*1965*) implicated stub cotton production with increasing populations of the pink bollworm.

The production of perennial (stub) cotton was banned in Arizona in 1966 to insure a host-free period for the pink bollworm and for the boll weevil, *Anthonomus grandis* Boheman. No stub cotton was legally grown in Arizona between 1966 and 1978. The 1977-78 winter, however, was exceptionally mild, and much of the cotton-producing community recognized the opportunity to produce stub cotton and reap the benefits of fewer field operations early in the 1978 season. Legislative recognition of the situation was obtained and nearly 10 percent of Arizona's 1978 short staple cotton was produced on 1977 rootstalks. Much of the cotton-producing community recognized the dangers historically associated with stub cotton. The results of the 1978 season will be studied intensively by those seeking to justify their various positions.

We cannot deal here with the general results obtained in the Arizona 1978 stub cotton program. We will draw some conclusions from our data for a single field, recognizing that they may not apply elsewhere.

The grower who managed our subject field was able to achieve a relatively good yield with minimal production costs. These results, in our opinion, were obtained because early (April to May) populations of the cotton leafperforator,

cotton aphid, *Lygus* bug, and the pink bollworm did not require the applications of insecticides. These insects were all present early in the season and were apparently under natural control. When the pink bollworm was able to infest bolls in June, the grower had little choice but to apply insecticides; however, the prolonged use of insecticides was not required because the grower began to terminate the crop in late August. The anticipated infestation by *Heliothis* did not appear until August when much of the crop was maturing. Thus, the benefits of an early and economical start were not offset by increased costs associated with late-season cotton production. We believe this was the key to balanced production costs and yield for this grower.

The pink bollworm is a key pest in Arizona cotton production and is exposed to predation until bolls are available for larval development. If the chemical control of this and secondary pests can be delayed until fruiting is underway, the predator populations will have an opportunity to control secondary pests as well. In the present study, the Delta traps were filled daily with pink bollworm moths during May while hardly an infested bloom could be found. At this same time, however, the field contained very large numbers of predators, which must have exerted strong control on pink bollworm larvae. This is the desired situation, and it should be preserved as long as possible when it occurs.

Wene et al. (*1965*) studied overwintering of the pink bollworm in Maricopa County, Ariz. Their data indicated major emergence from mid-April to mid-May (77 percent emergence by May 25). This overwintering pattern matches our early season trap catches very well. Without perennial cotton, it can be argued that much of this emergence is "suicidal;" however, Butler (*1979*) found that native pink bollworm moths can survive 6 to 8 weeks at 21° to 27° C and, therefore, may survive to infest cotton. A large "suicidal emergence" may also be suspect from an evolutionary point of view. At this point, we cannot say that many overwintering moths would die if perennial cotton were not available; however, the early availability of perennial cotton would certainly increase the chances of survival and reproduction for moths emerging early in the season.

In summary, we observed that economical production of perennial cotton was achieved in our experimental field during the 1978 season. Historically, the effects of continued stub cotton production over several years has lead to increased populations of insects pests, particularly the pink bollworm in Arizona. However, recent technology, including insect scouting, effective insecticides, and early termination of the crop (Bariola et al., *1976*), indicate that stub cotton production, particularly on a discontinuous basis, may need to be reevaluated. The effect of early termination on the production of stub cotton in the same field the following season also needs to be determined. Producers should be well aware of the hazards involved in stub cotton production and should make every effort to use the latest technology in achieving balanced yields and production costs.

LITERATURE CITED

(1) Arndt, W.
1961. The continuous cropping of cotton at Katherine, N. T. C.S.I.R.O. Division of Land Research and Regional Survey. Technical Paper No. 17, p. 12.

(2) Bariola, L. A., D. L. Kittock, H. F. Arle, and others.
1976. Controlling pink bollworms: effects of chemical termination of cotton fruiting on populations of diapausing larvae. Journal of Economic Entomology 69(5):633-636.

(3) Butler, G., and N. Foster.
1979. Longevity of adult pink bollworms at constant and fluctuating temperatures. Annals of the Entomological Society of America 72(2): 267-268.

(4) Ellern, S. J.
1966. Ratoon (biennial) cotton in Israel. Cotton Growing Review 43(1): 33-36.

(5) Evenson, J. P.
1970. Ratooning of cotton: a review. Cotton Growing Review 47(1):1-7.

(6) Flint, H. M., R. L. Smith, L. A. Bariola, and others.
1976. Pink Bollworm: trap tests with gossyplure. Journal of Economic Entomology 69(4):535-538.

(7) Fye, R. E.
1976. Improved method of holding cotton bolls for detecting pink bollworms. U.S. Department of Agriculture, Agricultural Research Service, Western Region, ARS-W-37, 3 p. [Series discontinued; Agricultural Research Service is now Science and Education Administration-Agricultural Research.]

(8) Mulder, C. E. G.
1965. Ratoon does not pay. Farming in South Africa 41:45-47.

(9) Naude, T. J.
1965. Ratoon cotton, a breeding place for insects. Farming in South Africa 41:37-39.

(10) Noble, L. W.
1969. Fifty years of research on the pink bollworm. U.S. Department of Agriculture, Agriculture Handbook No. 37, 62 p.

(11) Templeton, J.
1925. Ratoon cotton in Egypt. Ministry of Agriculture Bulletin No. 55, 28 p.

(12) Van Schaik, P. T., D. C. Erwin, and M. J. Garber.
1962. Effects of time of symptom expression of the leaf crumple virus on yield and quality of fiber of cotton. Crop Science 2(3):275-277.

(13) Wene, G. P.
1965. Cotton. College of Agriculture Report. Series P-1. University of Arizona. P. 63-64.

(14) ________ L. W. Sheets, H. E. Woodruff, and others.
1965. Winter survival of the pink bollworm in Arizona. Arizona Agricultural Experiment Station, Technical Bulletin No. 170, 23 p.

LIST OF CHEMICALS MENTIONED IN THIS PUBLICATION

Chemical designation	*Chemical name*
DEF	*S*,*S*,*S*,-tributylphosphorotrithioate.
Gossyplure	1:1 ration of *Z*,*Z*- to *Z*,*E*- isomers of 7, 11 hexadecadienyl acetate.
Monocrotophos	Dimethyl phosphate ester with (*E*)-3-hydroxy-*N*-methylcrotonamide.
Parathion	*O*,*O*-diethyl *O*-(*p*-nitrophenyl) phosphorothioate.
Resmethrin	(5-benzyl-3-furyl)methyl cis-trans-(±)-2,2-dimethyl-3-(2-methylpropenyl)cyclo+propane-carboxylate.
Toxaphene	Chlorinated camphene containing 67 to 69 percent chlorine.

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